REMARKS

This amendment is responsive to the Official Action mailed January 24, 2003, and is accompanied by a *Petition for Extension* and the required fee. Original claims 2-6, 9-13 and 16-20 are pending. Claims 1, 7, 8, 14 and 15 have been canceled, without prejudice.

In the official action, claims 7 and 14 were rejected under 35 U.S.C. §101. Claims 7 and 14 have been canceled, without prejudice. Reconsideration and withdrawal of the rejection under section 101 is requested.

Claim 8 was rejected under 35 U.S.C. §112, second paragraph for difficulties with the recited activity of "*sorting*." Corresponding claim 9 has been amended to include the subject matter of claim 8, canceled hereby without prejudice, and amended as well to more particularly and distinctly define the subject matter of the invention and to better distinguish over the prior art. The matters to which the examiner refers have been corrected. The recitation of the activity of "*sorting*" and the like has been changed throughout to "*determining*" and the like. The claims as amended are definite. Reconsideration and withdrawal of the rejection under section 112, second paragraph, is requested.

Claims 1-5, 7-8 and 14-15 were rejected under 35 U.S.C. §102(b) as anticipated by the reference of Johnston et al. (U.S. Pat. 5,426,977). Claims 6, 13 and 20 were rejected under 35 U.S.C. §103(a) as unpatentable over the same reference of Johnston et al., in further view of the reference of Keromnes et al. (U.S. Pat. 5,017,003). Claims 9-12 and 16-19 were rejected under 35 U.S.C. §103(a) as unpatentable over the Johnston et al. reference, in further view of the reference of Moayeri (U.S. Pat. 5,728,939).

Reconsideration of claims 2-6, 9-13 and 16-20 is respectfully requested. The claims as amended particularly and distinctly define the subject matter of the invention. The differences between the invention and the prior art of record are such that the subject matter claimed as a whole is not shown by the prior art to have been known or obvious to a person of ordinary skill in the art at the time the invention was made.

Claim 2 has been rewritten in independent form and includes the subject matter of independent claim 1, which was canceled. Claim 2 recites a method for determining whether avian eggs are qualified or unqualified for a premium quality based on shell characteristics. The

method includes the steps of oscillating the shells of each egg by a non-contacting source of ultrasonic waves to obtain a single measurement from the oscillating shells that is detectable by a non-contacting detector, as well as determining whether each egg is qualified or not from analysis of the single measurement. Wherein, the single measurement comprises information comprising at least detected power as a variable against detected time-of-flight from source to detector and further comprises an information portion that is analyzed for a positive indication consisting of two sufficiently steady and strong peaks.

Claim 2 was rejected under 35 U.S.C. §102(b) as being anticipated by Johnston et al. In the Official Action, it is stated that "*Johnston et al. disclose the detected signal comprises an information portion that is analyzed for a positive indication comprising at least one sufficiently steady and strong peak....*"

Reconsideration is requested. There is no teaching or suggestion in Johnston et al. concerning analyzing a single measurement for detected power (or signal strength) against time-of-flight values for not one but two sufficiently steady and strong peaks, as particularly and distinctly defined. In consequence, applicant respectfully requests withdrawal of the stated rejection.

The matters recited in amended claim 2 have always been of importance to the inventor, and are not recent contrivances to distinguish the invention over the prior art. For instance, the specification recites:

> *Generally speaking, in FIGURE 4 the first peak in time (eg., at ~222 μsec as distinguished from the peak at ~235 μsec)) has been discovered to most strongly correlate with egg shell quality. Hence the first peak in time might correspond to primary characteristic mode of oscillation whereas the second peak in time might correspond to a secondary mode, although to date this has not been established either way.*
> Page 13, lines 6-10.

The reference of Johnston et al. practices a conceptually distinguishable methodology known as '*resonant ultrasonic (or acoustic) spectroscopy.*' The goal of such is to determine any natural resonance frequency of an object. Advanced methodologies determine easily in excess of fifty (50) resonances of an object. Johnston et al. recite what their enterprise is all about in part by the following passages:

A swept frequency spectrum analyzer, controlled by a [PC] 20, analyzed the detected signal from [detector] 14, and further controlled frequency sweep generator 22, which generally was used to drive [source] 10 in the range between 400 Hz and 2000 Hz with a sweep duration or 5 to 10 seconds for most measurements.
Col 3, lines 36-41.

* * *

Egg resonances are referred to as vertical or horizontal depending on...direction of vibrational excitation.... Therefore, vertically disposed eggs are excited along their long axes, while horizontally disposed eggs short axes. FIG 2 shows a typical resonance curve for a normal egg with no holes or Salmonella bacteria, and the egg oriented vertically. There is a single resonance peak around 830 Hz. No other significant vertical resonances were found between 20 Hz and 100 kHz. No resonances were observed if the eggshell had a crack greater than 1 cm in length.

The horizontal resonance spectra were not found to be significantly affected by the treatment given the eggs. Generally, only one resonance peak having a center frequency near 680 Hz with an amplitude typically 3 to 4 times greater in magnitude than the vertical peak was observed. It is believed by the inventors that this difference in the resonances between the two orthogonal directions can be explained by the fact that the egg is mechanically stronger (analogous to a higher spring constant) in the vertical (major-axis) direction than in the horizontal (minor-axis) direction.
Col. 4, line 60, through col. 5, line 16.

Again, Johnston et al. are practicing a version of '*resonant ultrasound spectroscopy.*' According to a leading text book on this methodology, from authors in Los Alamos National Laboratory and the National High Magnetic Field Laboratory respectively,

...for the resonance method, the system is excited with an essentially pure tone, measurements are made for a while, and then the tone is changed slightly before another measurement is made. This approach enables the observer to map out the shape of the resonance with very high resolution.

A. Migliori and J.L. Sarrao, Resonant Ultrasound Spectroscopy (John Wiley & Sons: New York 1997), p. 64.[1]

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1 *In making a resonant ultrasound spectroscopy (RUS) measurement, the signal into the electronics varies as the signal source frequency moves through a resonance. The signal is, therefore, changing. The electronics must be able to respond to this change, so its bandwidth cannot be zero. A typical resonance might occur at 1 MHZ with a Q [eg., ~ area under a bell curve withing two or so standard deviations] of 10,000. The resonance is about 100 Hz wide. We might make measurements every 5 Hz over several times the width of the resonance so that we would step maybe over a 1-KHz range, and we better not do the whole sweep faster than*
(continued...)

The key passage from the foregoing footnote includes the following:

> *....We can either drive suddenly right on the resonance and wait, obtaining only one data point if we knew the resonance frequency exactly, an unlikely state of affairs, or we can slowly creep through the resonance and later take the response curve and fit it to find the resonance frequency.*
>
> Ibid (this time, emphasis supplied).

Unlike Johnston et al. and/or RUS, applicant/inventor hereof is indeed taking the equivalent of one data point. And the information applicant/inventor is scrutinizing that data point for has nothing to do with resonance, but twin peaks in the time-of-flight profile (ie., inside the excluded part of the measurement, or in other words, faster than the speed of sound in air).

At the time of filing of the original application papers, applicant/inventor had these remarks on the twin peak phenomena:

> *....Hence the first peak in time might correspond to primary characteristic mode of oscillation whereas the second peak in time might correspond to a secondary mode, although to date this has not been established either way.*
>
> Page 13, lines 8-10.

That is still a true statement. Nevertheless, considerable effort has been made to gain a better understanding. What follows is an abstract of three competing explanations.

I. The experts' explanation.

Applicant/inventor consulted his vendors (ie., at SecondWave Systems, Inc., State College, Penna.), who explain the twin peak phenomena as a product of a clockwise surface wave for one peak in contrast to a counterclockwise surface wave for another peak. Accordingly, if an egg were aligned perfectly between the source and detector, the twin peaks ought to merge into one.

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[1](...continued)

the response time of the resonator of about 10 ms. This is an important point. If we suddenly started driving the resonator on the resonance, it would take several time constants for the amplitude to reach within 1% of its ultimate value. The value of 1% is a reasonable number to settle on (!) For this type of measurement. If, instead of suddenly driving the resonator on the resonance, we began driving nearby and slowly approached the center frequency, then the response would build up slowly as well. In either case, we can't get a free lunch. We must wait 10 ms before we get 1% accuracy. We can either drive suddenly right on the resonance and wait, obtaining only one data point if we knew the resonance frequency exactly, an unlikely state of affairs, or we can slowly creep through the resonance and later take the response curve and fit it to find the resonance frequency....

Ibid (exclamation point is in the original).

Despite much exchange between applicant and his vendors, applicant has never been convinced of this explanation. The proffered explanation seems to suggest that the egg has two hula hoops being spun around its waist, one going CW and the other CCW. However, applicant's experiments show that the absolute spacing and relative proportions between the peaks for any egg is not changed by moving the egg about between the source and detector. Not only can he not find the point of perfect alignment, an obviously misaligned egg gives fairly much the same profile (absolute power values aside) regardless if the egg is obviously asymmetrically misaligned or centered as best can be done. The only difference in the profile is either it is steeper or flatter, but other wise the spacing between the peaks remains the same.

Migliori et al. describe what they consider to technically comprise surface waves. What is attractive about the surface wave explanation is that the speed of sound in a surface wave is slower than the speed of sound in the object. Presumptively, the earlier-in-time peak might correspond to acoustic wave propagation through the shell itself while the later-in-time peak might correspond to acoustic wave propagation via surface wave modes.

> *The very odd surface acoustic or Rayleigh waves that result have displacements that decay to zero from the surface with a characteristic length slightly less than the shear wavelength, and travel with a speed slightly lower than the shear wave speed (from about 87.4% of the shear speed...to about 95.5%...).*
> Migliori et al., p. 33.

What is untenable about the surface wave explanation is the exacting circumstances required to produce such[2], it being unlikely such are duplicated in the present invention.

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[2] *Consider a semi-infinite (it extends toward $z=-\infty$) isotropic solid whose surface is perpendicular to the z axis in which a shear oscillating disturbance is generated by touching the surface along a line and shaking it perpendicular to the line. Such a force will produce compressional forces parallel to the surface as well as shear forces. The shear forces will launch shear waves radiating perpendicular to the surface, with the directional dependence of the amplitude such that the intensity decreases from a maximum perpendicular to the surface to zero parallel to the surface. Longitudinal waves will be launched with maximum amplitude parallel to the surface, decaying to zero perpendicular to it. Now add a second line of force, identical and parallel to the first and exactly out of phase with it, but less than a half-wavelength of shear waves (and hence considerably less than half-wavelength of compressional waves as well) away, and then many more, all equally spaced. The longitudinal wave antinode leaving the first line arrives at the second line not in phase with the second line of force, so partial cancellation occurs. This gets worse and worse as the waves from all the sources add up in what amounts to a random way, eventually killing the wave altogether. The shear waves also cancel because the sources are out of phase and so no net shear of the surface occurs, or, alternatively, the shear waves leaving the surface are made up of equal numbers of waves with one phase and equal numbers with exactly the opposite phase so they all cancel. The end result is that such an array of sources produces no propagating waves of an sort. Well, not quite. There*

(continued...)

II. Applicant/inventor's explanation.

Applicant/inventor observes that an eggshell is not a uniform structure, but essentially can reckoned as being composed of distinct outer and inner layers respectively. The outer layer is referred to as the 'vertical crystal layer' and the inner layer is referred to as the 'palisade layer.' See, eg., S.E. Solomon, Egg & Eggshell Quality (Iowa State Univ. 1997), selections submitted with applicant's Information Disclosure Statement. The 'palisade layer' is characterized by closely-packed elongated members that extend from roots in a softer root layer and terminate in the 'vertical crystal layer.'

Accordingly, applicant/inventor theorizes that one peak corresponds to the speed of sound in the 'vertical crystal layer' and the other peak corresponds to the speed of sound in the 'palisade layer.' To this the experts reply, not likely, the two layers as a whole probably respond as a unit in propagation of acoustic (or stress waves).

The attractive part of applicant/inventor's approach is indeed eggshells have a complex structural order to themselves. The observed twin peak phenomena might truly be resolved by thinking harder how such a structure as an eggshell changes the received signal from the source into the detected signal observed through the signal analyzer.

To date no explanation suffices in all particulars.

III. An alternative explanation.

The undersigned has scanned through the Migliori textbook and has therein encountered descriptions of various non-obvious phenomena with propagation of stress waves. One deserves mention. Preliminarily,

> *Propagating stress waves are just elastic waves of various types such as longitudinal, shear, surface and more. Because solids support such a variety of waves, and because few of them can produce sound, it is better not to call them sound waves, although such usage is common....*

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[2](...continued)
is a magic frequency such that for any given spacing of out-of-phase force producers, a wave will launch parallel to the surface, composed of complex elliptical motion of the atoms, that is neither shear nor longitudinal and that moves at slightly less than the shear wave speed.

Ibid., pp. 31-32.

Consider the following simple system where we have a long, thin rod with area A, length L, and density ρ.... We now consider all the forces acting on thin plug between x and x + Δx.... [T]he restoring forces will arise...from the resistance the solid itself presents when any attempt is made to change its shape. We could attempt to change the shape by twisting, bending, stretching-compressing, or some combination of these.

The constants that tell us what the resistance to deformation is are called 'elastic modulii,' and there, in general, lots of them.
Migliori et al., p. 10.

Further on, when describing transducer design,

...The root of the problem is that mother nature has refused to make the world's fastest sound wave occur [it being in diamond] in a viable piezoelectric.... As usual, we can't cheat by using a thin disk made from a lower-sound-speed piezoelectric. Although such a disk would have a compressional- or thickness-mode resonance agreeably high, its drum-like and bending modes would be quite low. For example, a properly cut 1.5 mm diameter single-crystal $LiNbO_3$ (lithium niobate) transducer 0.4 mm thick has a first compressional mode at 30 MHZ. However, its lowest mode (probably a bending deformation) is around 190 kHz, disastrously low.
Ibid, p. 75.

To apply this lesson to the present invention, one of the two peaks perhaps corresponds to stress wave propagation by one mode as the other corresponds to propagation by another mode wherein the different modes are characterized by different speeds of sound through the eggshell. That is, the earlier-in-time peak might correspond to compressional-mode propagation as the later corresponds to drum-like or bending mode propagation. Compressional mode propagation might likened to ripples on a still pond. The ripples radiate away from the center. On an eggshell, the input of source energy is received on a point[3]. A stress-wave ripple is launched, radiating from the focal point around the whole of the shell as a thin hoop of Δ-circumference stress (ie., the circumference being not that of the shell in any cross-section but of the expanding and dissipating ripple) in the thickness of the shell. In contrast, a different mode of propagation might be bending or drum-like flexure in the shell, which is a relatively more macroscopic deformation, and is more nearly illustrated by FIG. 2 of the present specification.

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[3] *It has been learned recently that the transducers described in the specification as NCT 102 transducers of SecondWave Systems, Inc., State College, Pennsylvania, focus their energy into a point, something like a propane torch is focused into a cone converging in a point, or tip.*

In view of the foregoing, applicant/inventor is practicing a patentably distinguishable enterprise over that of Johnston et al. Indeed, Johnston et al. teach away from the applicability of their technique as useful to the present invention where they recite:

> *Before each measurement, the egg was gently shaken for a few seconds to dislodge the yolk from the shell membrane in case the yolk was partially attached. This permitted good reproducibility of the data if the measurements were repeated on any given egg.*
> Co. 3, lines 45-49.

Applicant/inventor's goal is not to kill but provide early detection for which eggs to graduate to hatchery operations.

Claim 2 is allowable because the prior art lacks the premises of the invention as claimed, and fails to disclose or suggest methodologies comparable to that claimed, performing similar functions and providing the advantages of the invention disclosed and claimed only by applicant.

Moreover, the prior art fails to disclose or suggest that two peaks in time-of-flight analysis as obtained from only one (ie., a single) measurement have such advantages for predicting egg viability for hatchery operations. Thus the invention as particularly and distinctly defined in claim 2 is neither disclosed nor suggested in the prior art.

Allowance of claim 2 is therefore appropriate and is hereby requested.

Claims 3 through 6 depend from claim 2 and are allowable for the same reasons set forth above. Claims 3-6 recite further aspects of the invention and each, when given separate consideration *as a whole*, is patentable in its own right.

Claim 3 (and somewhat comparably claim 5) states that the information portion of the detected signal excludes signal-strength information for times of time-of-flight slower than a benchmark corresponding to the time-of-flight value obtained in the absence of any egg or other object between the source and detector. That is, this limit is the speed of sound in air. Such slower times of time-of-flight presumptively correspond to reflected noise. This aspect is likewise not found in the prior art relied upon. Johnston et al. alone or in combination with the other references fails to lead routinely to the invention claimed *as a whole*.

Claim 4 recites that the positive indication of a qualified eggshell as obtained by the two peak determination is correlatable to fertility or hatching or hatchling viability. The aspect plainly distinguishes the claim 4 from Johnston et al. In claim 6, eggs qualified for premium quality are graduated to hatchery operations. There is no basis to believe that the invention defined by claim 6 *as a whole* would have been obvious to a person of ordinary skill. The prior art does not reach the invention as a whole.

Reconsideration of claims 9-13 and 16-20 is respectfully requested. No new matter is presented. The application as filed provides fully adequate support to the terminology of the pending claims. Allowance of these claims is requested because these aspects of the invention claimed *as a whole* are not disclosed or suggested by the prior art of record, whether considered individually or in any routine combination.

Every effort has been made to particularly and distinctly define the subject matter of the invention. The claims are definite, and are patentable over the prior art of record. The differences between the invention and the prior art are such that the subject matter claimed as a whole would not have been known or obvious to a person of ordinary skill in the art. Reconsideration, and allowance of all the pending claims, are respectfully requested.

Respectfully submitted,

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